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(54) Method of determining authorization of the user of a subscriber set

(57) The authorization of the user of a portable personal automatic telephone is partly determined by comparing the voice characteristic of the user with that of the authorized person and is further determined by comparing the fingerprint pattern of the user with the fingerprint pattern of the authorized person.
　The arrangement includes a processor (5) which compares stored characteristics (ROM 1, 3) with user entered characteristics (RAM 2, 4). The switch (10) can be operated in response to correlations between one or both of the characteristics depending on the use to which the set is to be put.

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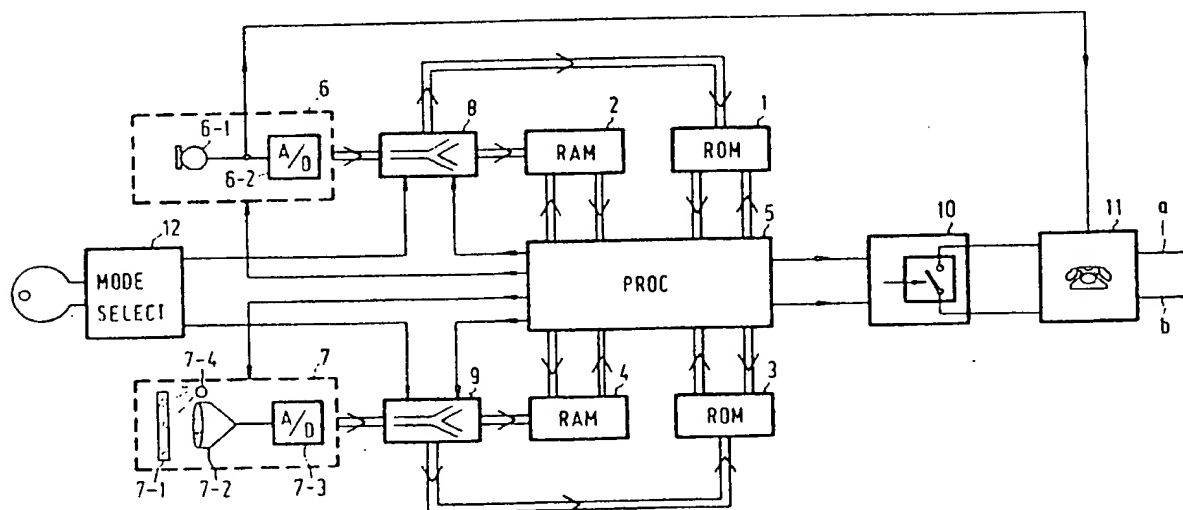
SPECIFICATION

Determining the user authorization of a subscriber set for signal transmission

5
The invention relates a method of determining whether a user is authorized to use a subscriber set for signal transmission and to a subscriber set for signal transmission including
10 user authorization determining means.
Such a method and such a subscriber set are disclosed in European Patent Specification No. EP–B1–0 027 596.
Generally, it is useful to provide a subscri-
15 ber set for signal transmission, such as, for example, a telephone set with a protection against unauthorized use, as the use of the subscriber set is always charged to the subscriber. With the present-day development of
20 mobile subscriber sets (for example the so-called automatic personal telephone, as described in the article ''The cellular telephone goes on line'', published in the periodical ''Electronics'' of 22nd September 1983,
25 pages 121–129), special account must be taken of the risk of non-authorized use. These portable sets may be found abandoned more frequently than wired sets, for example in the event of loss or theft.
30 It is already known to protect the subscriber set from unauthorized use by providing it with a lock to prevent unauthorized use. The authorized user identifies himself by using the appropriate key. The subscriber set may alterna-
35 tively be arranged such that it is capable of recognizing a code on an identification card of the authorized person. These known manners of protection have the disadvantage that a physical identification device (key or card) is
40 always necessary which may get lost.
From the above-mentioned European Patent Sepcification it is known to determine the user authorization of a telephone set by comparing the voice characteristic of the user with the
45 voice characteristic of the authorized person. The human voice is an individual, unambiguous characteristic. With this personal characteristic it is possible to try to identify the owner of the voice unambiguously, so that in
50 this way of determining the user authorization no physical identification device is required.
Several methods of identifying a person by means of his voice pattern are known. In all these methods the error probability, (i.e. the
55 probability that a speaker is erroneously identified as non-authorized or a non-authorized speaker is erroneously identified as authorized) depends on the available computer and memory capacities and on the available com-
60 puting time. If a great deal of memory capacity is available the speech samples can be stored in amore extensive form, which requires more computing time, such as described in, for example, the article ''Talking
65 with computers: Synthesis and Rocognition of-

Speech by Machines''; IEEE Transactions on Biomedical Engineering, Vol. BME–29, No. 4, April 1982, Pages 223–232, more specifically page 230, paragraph III–F.
70 When determining the user authorization of a subscriber set for signal transmission it is undesirable for time necessary to arrive at a decision whether the set will be enabled or not, to be longer than a few seconds, as this
75 would be annoying for the user. With a prescribed processing rate of the data such a fast decision can be relaized by limiting the number and size of the recorded speech samples, but this increases the error probability. More
80 extensive recording of the speech samples implies a larger storage capacity and higher processing rates which, for reasons of cost and volume, is undesirable, especially with portable subscriber's sets such as used in said
85 system of automatic personal telephones.
It is an object of the invention to provide a method of determining whether a user is authorized to use a subscriber set in which the error probability is reduced without signifi-
90 cantly increasing the decision time, and which is suitable for portable subscriber sets of the automatic personal telephone system. It is a further object of the invention to provide a subscriber set for signal transmission includ-
95 ing user authorization means in which the error probability is reduced without significantly increasing the decision time.
The invention provides a method of determining whether a user is authorized to use a
100 subscriber set for signal transmission and enabling the subscriber set if authorization is determined, said method comprising the steps of: comparing a representation of a first characteristic of the authorized user, which charac-
105 teristic is stored within an authorization determining means, with a corresponding representation of the first characteristic entered by the user to the authorisation determining means; producing a first decision signal indicating
110 whether a sufficient correlation between the stored and entered representations of the first characteristic exists to imply that the user is the authorised user; comparing a representation of a second characteristic of the author-
115 ised user, which characteristic is stored within the authorisation determining means, with a corresponding representation of the second characteristic entered by the user into the authorisation determining means; producing a
120 second decision signal indicating whether a sufficient correlation between the stored and entered representations of the second characteristic exists to imply that the user is the authorised user; and enabling the subscriber
125 set if the first and/or second decision signals indicate correlation between the stored and entered representations of the user characteristic.
The invention further provides a subscriber
130 set for signal transmission including user au-

thorisation determining means, said user au-
thorisation determining means comprising.
means for storing a representation of a first
characteristic of an authorised user; means for
5 entering the first characteristic of a potential
user and producing a corresponding represen-
tation thereof; means for comparing the
stored and entered representations of the first
characteristic and producing a first decision
10 signal which indicates whether a sufficient
correlation exists between the representations
of the stored and entered first characteristics
to imply that both were produced by the same
person; means for storing a representation of
15 a second charateristic of an authorised user;
means for entering the second characteristic
of the potential user and producing a corre-
sponding representation thereof; means for
comparing the stored and entered representa-
20 tions of the second characteristic and produc-
ing a second decision signal which indicates
whether a sufficient correlation exists between
the representation of the stored and entered
second characteristics to imply that both were
25 produced by the same person; means for
applying the first and second decision signals
to a subscriber set enabling means for produc-
ing an enabling signal when the first and/or
second decision signals indicate correlation
30 between the stored and entered character-
istic(s).
As the second personal characteristic is in-
dependent of the first personal characteristic,
the occurrence of incorrect decisions because
35 of mutually dependent error causes is obvi-
ated. These mutually dependent error causes
might, for example, be present if, to reduce
the error probability, the other personal char-
acteristic of the same type as the first personal
40 characteristic, for example the voice character-
istic, were chosen. In that case it is possible
that because of, for example, the fact that the
speaker has caught a cold or of permanent
interfering background noise an incorrect deci-
45 sion as regards the user authorization of the
speaker would continuously be taken.
With an embodiment of a method and a
subscriber set which are suitable for simple
and fast recognition the first personal charac-
50 teristic may be formed by the voice character-
istic and the second personal characteristic
may be a finger of thumb print. Since using a
subscriber set for signal transmission always
implies that is touched by the user this touch
55 can also be used for entering the finger print
so that no additional manipulations of the user
are required for this purpose.
An embodiment of the invention and its
advantages will now be described, by way of
60 example with reference to the accompanying
drawing, in which the sole Figure shows by
means of a block schematic diagram an ar-
rangement of a subscriber set for signal
transmission including user authorization de-
65 termining means.

The arrangement shown in the Fig. 2 com-
prises four memories 1, 2, 3 and 4, a pro-
cessing unit 5, two converters 6 and 7,
supply means 8 and 9, an authorization cir-
70 cuit 10 and a mode selector 12. The arrange-
ment is connected via the authorization circuit
10 to the further circuits of the subscriber set,
shown schematically in the Figure by the set
function circuit 11.
75 Memory 1 is a read-only memory, intended
to store a representation of the voice charac-
teristic of the authorized user. The term "read-
only memory" must be understood to mean
that the content of memory 1, and also the
80 content of the read-only memory 3 still to be
described, is not erased as part of the proce-
dure for determining the user authorization. It
is indeed possible that the read-only memories
1 and 3 are given a new content as part of a
85 procedure for writing a characteristic of an
authorized user into the memories. It is alter-
natively possible for the read-only memories 1
and 3 to be in the form of plug-in modules
which are programmed outside the subscriber
90 set.
The representation of the voice character-
istic may assume different forms, as known
from the prior art. For speaker recognition the
representation of the voice characteristic may
95 correspond to the representation for word
identification, as described in the afore-men-
tioned IEEE-Article. The manner of storing a
representation for word recognition is known
per se, for example from the periodical "Mini-
100 Micro Systems", June 1983, pages 242,
244 and 246, or from the periodical "Tele-
communication Journal", Vol. 48, December
1981, pages 734 and 735.
Memory 2 is an erasable memory, intended
105 to store a representation of the voice charac-
teristic of a person wanting to use the subscri-
ber set, called user hereinafter, which repre-
sentation corresponds to that stored in the
read-only memory 1.
110 Under the control of processing unit 5,
prior to the use for communication purposes,
the voice of the user is converted by converter
6 formed by a microphone 6-1 and an ana-
logue-to-digital converter 6-2- into a repre-
115 sentation of the voice characteristic, for
example into a set of digital code words each
representing a sample of the speech signal.
The set of digital code words can be read
directly into memory 2 under the control of
120 processing unit 5 or can be processed first by
processing unit 5 to form a different represen-
tation before being stored in memory 2. After
the representation of the voice characteristic
of the user has been stored in memory 2 it is
125 compared to the representation of the voice
characteristic of the authorized person. This
manner of comparing is known per se and is
described in, for example, said periodical
"Mini-Micro Systems", page 244. If both
130 voice representations show sufficient correla-

tion between each other, that is to say they are within a predetermined margin of each other, then the processing unit generates a first decision signal which indicates that the
5 two representations are sufficiently similar to be assumed to emanate from the same person.

Speaker recognition on the basis of the voice characteristic has an error probability in
10 the order of some percents. From said IEEE-article a value of 10% can be derived for the eror probability (page 230, paragraph III–F). From the above-mentioned periodical "Mini-Micro Systems", pages 244 and 246 a value
15 of 1% for the error probability for word recognition can be derived, but this value holds for uptimun circumstances and may be considerably more in actual use. As for word recognition a method is followed which corresponds
20 to the method of speaker recognition, it may be assumed that in both cases the error probability is of the same order of magnitude.

In order to reduce the number of times that the authorized user is not recognized as such,
25 or that an unauthorized person is identified as authorized, as the case may be, the identity of the user is checked against a second individual characteristic which is independent of the first individual characteristic. In this embodi-
30 ment the second characteristic is the finger print pattern.

In the read-only memory 3 a representation of the finger print pattern of the authorized user is stored. The manner of forming a
35 representation of the pattern of a finger print is known per se, for example, from United States Patent No. 4,210,899 and from the article "Reducing Storaged Requirements of Digitized Fingerprint Images", 1982 Carna-
40 han Conference on Security Technology, University of Kentucky, 12–14 May 1982.

Memory 4 is an erasable memory intended to store the representation of the fingerprint pattern of the user. Entering the fingerprint
45 pattern of the user into 4 the memory is effected in parallel with entering the voice characteristic of the user into the memory 2. To this end the subscriber set is provided in a suitable place with a window 7–1 on which
50 the relevant finger is placed.

Window 7–1 forms part of a converter 7 for converting the fingerprint pattern into a representation suitable for storage and/or processing. In addition, converter 7 comprises a
55 lighting element 7–4, for example a small incandescent lamp, a camera 7–2 and an analogue-to-digital converter 7–3. Camera 7–2 is a television pick-up element which is known per se, for example a CTD (Charge
60 Transfer Device)—element. Such a television pick-up element is, for example, the Philips RGS-4 solid-state image sensor. In response to the pressure of the finger on the window 7–1 the lighting element 7–4 is switched on
65 and camera 7–2 produces a signal representa-

tive of the fingerprint pattern. Under the control of processing unit 5 the camera signal is converted by anlogue-to-digital converter 7–3 into a set of digital code words which is either
70 directly stored in memory 4 or is first processed by processing unit 5 and then stored in memory 4.

After the representation of the fingerprint pattern of the user has been stored in memory
75 4 a comparison is made with the representation of the fingerprint pattern of the authorized user. The manner in which this comparison is effected is known per se from the prior art, such as, for example, said United States
80 Patent Specification and from said article of the "Carnahan Conference". If these two representations show sufficient correlation between each other, that is they are within a predetermined margin of each other, then the
85 processing unit generates a second decision signal which indicates that the two representations of the finger-print patterns are sufficiently similar to be assumed to be produced by the same person.
90 With the first decision signal which relates to correlation of the voice characteristics, and the second decision signal which relates to the correlation of the fingerprints the subscriber set can now be enabled for communication. It
95 is possible to enable the subscriber set if at least one of the decision signals indicates correlation; it is alternatively possible to only enable the set when both decision signals indicate correlation.
100 In the first case the probalility of non-recognition of the authorized user is small, but it is possible that an unauthorized person may be erroneously identified as being authorized. In the second case the probability of non-
105 authorized use is small, but the probability of non-recognition of an authorized user is increased. It is also possible to differentiate the enabling criteria on the basis of the intended use of the subscriber set. So it is, for
110 example, possible that for expensive international connection both decision signals indicating correlation are required, whilst only one decision signal indicating correlation is required for the less expensive national connec-
115 tions.

Entering the personal characteristics of the authorized user can be effected outside the subscriber set. It is alternatively possible for the authorized person to enter his personal
120 characteristics himself, after he has adjusted the subscriber set to a suitable state for that purpose, for example with the aid of a key, a magnetic identification card or with the aid of a nummerical code which is entered via a
125 number selection unit.

When the personal characteristics are entered by the authorized user himself, the subscriber set is adjusted with the aid of mode selector 12 in one of the above-described
130 ways to the state suitable for storing the

personal characteristics of the authorized user.
In this state the supply means 8 and 9 only
transfer the information from the converters 6
and 7 to the memories 1 and 3, respectively.
5 After the personal characteristics of the autho-
rized user have been stored, the subscriber set
is readjusted to the normal mode of usage by
removing the key or the identification card or
by applying an appropriated nummerical
10 code.

CLAIMS
1. A method of determining whether a
user is authorized to use a subscriber set for
15 signal transmission and enabling the subscri-
ber set if authorization is determined, said
method comprising the steps of:
   comparing a representation of a first charac-
teristic of the authorized user, which charac-
20 teristic is stored within an authorization deter-
mining means, with a corresponding represen-
tation of the first characteristic entered by the
user to the authorization determining means;
   producing a first decision signal indicating
25 whether a sufficient correlation between the
stored and entered representations of the first
characteristic exists to imply that the user is
the authorized user;
   comparing a representation of a second
30 characteristic of the authorized user, which
characteristic is stored within the authorization
determining means, with a corresponding
representation of the second characteristic en-
tered by the user into the authorization deter-
35 mining means;
   producing a second decision signal indicat-
ing whether a sufficient correlation between
the stored and entered representations of the
second characteristic exists to imply that the
40 user is the authorized user;
   and enabling the subscriber set if the first
and/or second decision signals indicate corre-
lation between the stored and entered repre-
sentations of the user characteristic.
45 2. A method according to Claim 1 in
which the first characteristic is a voice charac-
teristic.
   3. A method according to Claim 1 or 2, in
which the second characteristic is a finger or
50 thumb point.
   4. A method of determining whether a
user is authorized to use a subscriber set for
signal transmission and enabling the subscri-
ber set if authorization is determined, the
55 method being substantially as described
herein with reference to the accompanying
drawing.
   5. A subscriber set for signal transmission
including user authorization determining
60 means, said user authorization determining
means comprising means for storing a repre-
sentation of a first characteristic of an autho-
rized user; means for entering the first charac-
teristic of a potential user and producing a
65 corresponding representation thereof; means

for comparing the stored and entered repre-
sentations of the first characteristic and pro-
ducing a first decision signal which indicates
whether a sufficient correlation exists between
70 the representations of the stored and entered
first characteristics to imply that both were
produced by the same person, means for
storing a representation of a second character-
istic of an authorized user; means for entering
75 the second characteristic of the potential user
and producing a corresponding representation
thereof; means for comparing the stored and
entered representations of the second charac-
teristic and producing a second decision sig-
80 nal which indicates whether a sufficient corre-
lation exists between the representation of the
stored and entered second characteristics to
imply that both were produced by the same
person; means for applying the first and sec-
85 ond decision signals to a subscriber set en-
abling means for producing an enabling signal
when the first and/or second decision signals
indicate correlation between the stored and
entered characteristic(s).
90 6. A subscriber set as claimed in Claim 5,
in which the representations of the first an-
d/or second characteristics of the authorized
user are stored in one or more non-volatile
memories which is/are programmed outside
95 the subscriber set.
   7. A subscriber set as claimed in Claim 5,
in which the user authorization determining
means comprises a first transducer for con-
verting the first characteristic of the user into
100 an electrical signal, a second transducer for
converting the second characteristic of the
user into an electrical signal, means for tem-
porarily storing the electrical signals corre-
sponding to the first and second character-
105 istics of the user, and means for comparing
the stored authorized user representations and
the temporarily stored user representations.
   8. A subscriber set as claimed in any of
Claims 5, 6 or 7, comprising means for
110 enabling the authorized user characteristics to
be entered into one or more memories under
the control of a switching arrangement actu-
ated by the user.
   9. A subscriber set as claimed in Claim 7,
115 in which the switching arrangement is actu-
ated under the control of a key.
   10. A subscriber set for signal transmis-
sion substantially as described herein with
reference to the accompanying drawing.